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REPORT ON SHIPPING TESTS WITH EARLY POTATOES FROM KERN COUNTY, CALIFORNIA, 1938

By

W. R. Barger, associate physiologist, W. T. Pentzer, physiologist, G. B. Ramsey, senior pathologist, and J. S. Wiant, associate pathologist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture; and J. H. MacGillivray, Division of Truck Crops, and R. L. Perry, Division of Agricultural Engineering, California Agricultural Experiment Station.

(A cooperative investigation by the Division of Fruit and Vegetable Crops and Diseases, U. S. Department of Agriculture, and the Divisions of Truck Crops and Agricultural Engineering of the University of California at Davis.)

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Soon after digging, the potatoes were sacked and hauled to the packing shed. All potatoes were washed, the time between digging and washing being 1 to 4 hours, depending somewhat on the distance between the field and the shed.

Description of Shipments

All cars were shipped from Shafter, California. They contained washed U. S. No. 1 and various experimental lots of potatoes in 100-pound sacks with the exception of car F which contained egg-size stock. All cars were loaded alike with a through load; bottom layer, sacks upright, 6 wide; 2nd layer, sacks flat, 3 end-to-end across car; 3rd layer near bunkers only, same as 2nd, making 300 sacks per car. All refrigerated shipments were under Rule 240; initial ice, no re-icing in transit.

Car A, S.F.R.D. 16387. Shipped May 31; precooled to 48°; initial ice at Shafter; A.T.& S.F. to Chicago; unloaded June 7, 7:00 a.m.

Car B, S.F.R.D. 25830. Shipped June 1; precooled to 50°; vents open, no ice; A.T.& S.F. to Chicago; unloaded June 8, 7:00 a.m.

Car C, S.F.R.D. 23290. Shipped June 2; not precooled; standard ventilation. A.T.& S.F. to Chicago; unloaded June 9, 7:00 a.m.

Car D, S.F.R.D. 19816. Shipped June 9; not precooled; initial ice at Bakersfield. A.T.& S.F., Wabash, to Chicago; unloaded June 16, 8:00 a.m.

Car E, S.F.R.D. 21297. Shipped June 9; not precooled; initial ice at Needles; A.T.& S.F., T.P.W., N.K.P., Erie to New York City; unloaded June 18, 8:30 a.m.

Car F, M.D.T. 7368. Shipped June 10; not precooled. Initial ice at Bakersfield. A.T.& S.F., C.& A. to Chicago; unloaded June 17, 7:00 a.m.

Precooling Data

The precooling equipment used for cars A and B was of the ice water type. The sacks were placed on a conveyor one layer deep and passed through a shower of ice water before loading into the cars. The temperature of the shower was maintained at about 35° F. by recirculating the water through a tank containing crushed ice; each sack remained in the cooler for about 15 minutes during which time the temperature of the potatoes was lowered 30° or more. The temperature of the potatoes before cooling averaged about 78° in the morning, 83° at noon, and 87° during the afternoon while the average temperature after cooling was about 48° in the morning and 53° in the afternoon. About 4-1/2 tons of ice were used to cause this much cooling of a carload of 300 sacks.

In a preliminary test, it was found that tubers in the center of 100-pound sacks were cooled as readily as others not in sacks but placed two layers deep on the conveyor.

Temperature in Transit

The temperatures inside of sacks at the top doorway position in five cars while en route east are shown in figure 1. These temperatures were obtained from thermographs 1 to 10. Cars A, B, and C were shipped on three consecutive days, beginning May 31. They were routed alike and therefore encountered about the same weather. The temperature at Shafter was 96° when car A was loaded, 101° when car B was loaded, and 105° during the loading of car C. The temperature of the potatoes from the field ranged from 75° to 93°. In car A (precooled and iced at Shafter) a temperature between 48° and 50° was maintained for the entire trip. In car B (precooled, no ice) the load was 50° when it left Shafter and warmed up to 62° in 10 hours. Although the clock mechanism of the thermograph in this car stopped en route

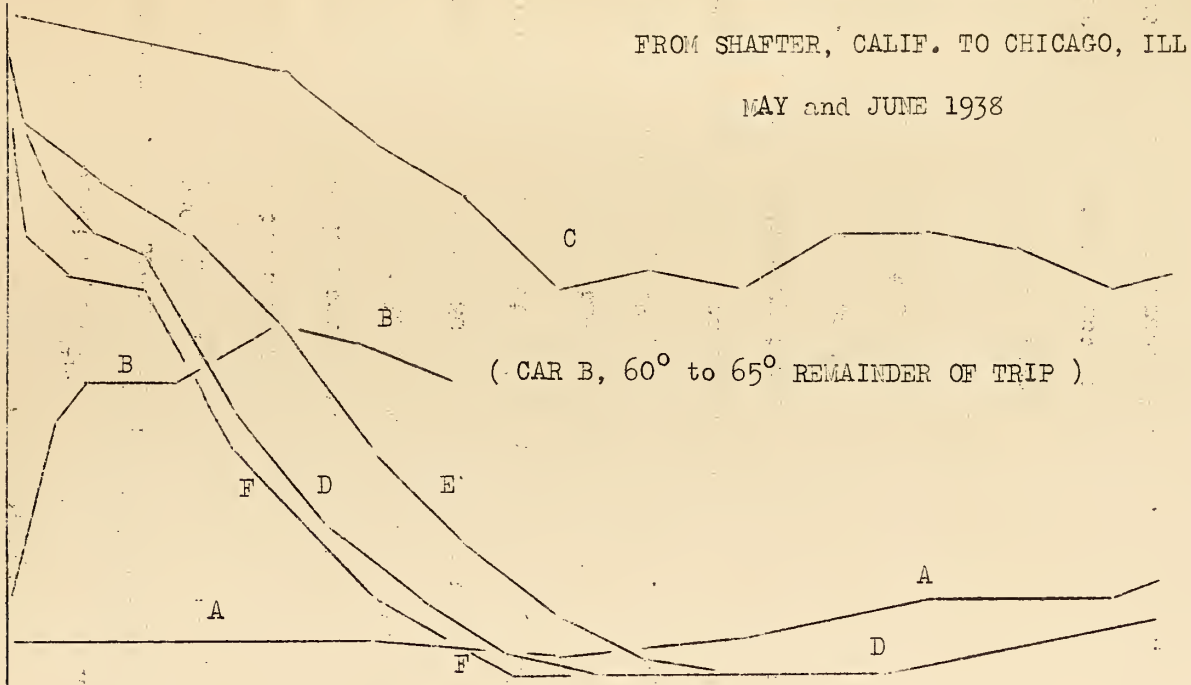
FIG. 1

TEMPERATURE OF POTATOES IN TRANSIT

TOP DOORWAY OF THROUGH LOAD OF 100 lb. SACKS

FROM SHAFTER, CALIF. TO CHICAGO, ILL.

MAY and JUNE 1938



A PRECOOLED & ICED AT SHAFTER, 5/31

B PRECOOLED, NO ICE, VENTS OPEN, 6/1

C NO ICE, VENTS OPEN, 6/2

D ICED AT BAKERSFIELD, SHIPPED 6/9

E ICED AT NEEDLES, SHIPPED 6/9

F ICED AT BAKERSFIELD, SHIPPED 6/10

the records obtained indicate that the temperature probably ranged from 60° to 65° during the trip. In car C (standard ventilation) the load was 82° when loading was finished and cooled only 3° during the first 36 hours en route. The temperature was 67° on the third day and remained between 67° and 70° for the rest of the trip.

Cars D and E were shipped on the same day (June 9). These cars were loaded on an unusually cool day for this time of year, followed by a cold night, and both loads cooled much faster under ventilation during the time before icing than did the ventilated load shipped May 31. The outside temperatures during this time were: minimum June9, 54°; maximum June 9, 86°; minimum June 10, 50°. Both cars cooled en route to a temperature of about 46° and then gradually warmed up to about 49°. Car D (iced at Bakersfield) showed a temperature of 50° after about 54 hours en route while car E (iced at Needles) lagged behind car D in temperature for 12 to 16 hours during the first four days. Car F (iced at Bakersfield) cooled slightly faster than car D.

The temperature at the bottom bunker was from 10° to 15° colder than that at the top doorway during the first 48 hours en route, and was from 4° to 10° colder during the rest of the trip, the greatest difference occurring soon after icing.

Ice Used

Car A (precooled and iced at Shafter) arrived at Chicago with the bunkers one-third full of ice. About 4-1/2 tons of ice was used during precooling.

Car D (not precooled, iced at Bakersfield) arrived at Chicago with about 50 pounds of ice in each bunker.

Car E (not precooled, iced at Needles) arrived at New York City with about 300 pounds of ice in each bunker.

Car F (not precooled, iced at Bakersfield) arrived at Chicago with about 300 pounds of ice in each bunker.

The two Chicago cars (D & F), iced at Bakersfield, and the New York car (E), iced at Needles, were all under ice for about the same length of time. This explains why the New York car arrived with as much ice as the Chicago cars. Nearly all the ice was melted in car D between Bakersfield and Chicago and since this car was loaded during moderate weather the indication is that during hot weather all cars may not carry as far as Chicago without re-icing. The lack of ice in car D was reflected in the temperature of the potatoes on arrival which was 4 to 5 degrees higher than in car F.

Description of Deterioration

Poor condition of the tubers when noted on arrival was due to severe discoloration, scald, and decay.

For the purposes of this report, scald is defined as definitely sunken areas that may or may not be bleached. Absence of bleaching is believed to indicate that the injury was caused by excessive heat rather than by direct sunlight. Experimental tubers exposed to sunlight and heat in the field for 30 minutes or longer showed bleached, sunken, scalded areas.

Severe discoloration or browning (figures 2 and 3) occurred wherever the tubers had been skinned. With commercially handled stock practically all skinned and brown areas occurred at the bud end.

Decay was of the bacterial soft rot type mostly following scald or on severely skinned areas. Skinned and discolored areas often become sticky from bacterial growth on the surface. Very little decay occurred in any shipment.

Fig. 2 - Browning of skinned area on early Shafter potatoes.

1. After 10 days at 70°, low humidity.
2. After 10 days in electric refrigerator, low humidity.
3. After 10 days at 70°, covered with vaseline.

Fig. 3 - Browning of skinned area on early Shafter potato.

Desiccated flesh of horn-like consistency under browned surface. After 20 days in electric refrigerator, low humidity.

Effect of Sunlight and Wind

The summary of the inspections of potatoes exposed to sun and wind for various lengths of time after digging is given in table 1. The experimental lots were prepared by Mr. W. Rutledge of the Federal-State Inspection Service and forwarded by express to Chicago where they were inspected by Dr. G. B. Ramsey.

When potatoes were exposed to wind, the wind was produced mechanically by placing the sacks of tubers on the running board on the shady side of an automobile and driving it at 30 miles an hour. The tubers exposed to sunlight were protected from wind during exposure and were carried inside a closed car to the shed.

Table 1. Effect of sun and wind on condition of potatoes after shipment by express from Shafter to Chicago

Treatment, at Shafter, June 3 /1	Condition at Chicago, June 10		
	Discolored	Scalded	Decayed
	%	%	%
Exposed to sunlight 1 hour	48	37	4
Do do do 45 min.	38	17	3
Do do do 30 min.	33	7	0
Do do do 15 min.	23	0	0
Not exposed to sunlight	11	0	0
Shaded, exposed to wind 15 min.	79	0	0
Do do do do 30 min.	88	0	8

1/ Tuber temperatures, 98° to 102° F. Shade temperature, 111° F.

Effect of Transit Temperature

The market inspection of U. S. No. 1 potatoes in the sacks containing the thermographs in the various experimental cars is given in table 2.

Table 2. Effect of transit temperature on condition of Shafter potatoes after arrival at eastern market

Car	Transit Refrigeration	Condition upon arrival at market			
		Discolored %	Sticky Surface %	Scalded %	Decayed %
C	None, ventilated	15-20	15-20	-	10
B	Precooled to 50° ventilated	10	1-3	-	Very slight
A	Precooled to 50° Rule 240, ice Shafter	0	0	-	0
D	Rule 240, ice Bakersfield Top doorway	Many bud ends	1 1/	5	0
	Bottom bunker	do	6 1/	6	0
E	Rule 240, ice Needles	Car arrived in sound condition with no objectionable discoloration or scald			

1/ Infected scald area.

Effect of Drying

In car F, iced at Bakersfield, experimental lots of excessively wet tubers (having had water poured on them just prior to loading), dry tubers (having been dried with fans), and tubers of intermediate dryness (commercial run) were placed at the bottom bunker and top doorway positions. The results of the terminal inspection are given in table 3.

Table 3. Effect of drying on condition of washed Shafter potatoes after shipment to Chicago

Treatment	Location in car	Condition upon arrival in Chicago		
		Discolored	Sticky Surface %	Decayed %
Wet	Bottom bunker	Very few	8.6	1.4
Do	Top doorway	Few	7.3	2.2
Medium dry	Top doorway	Few	---	---
Dry	Bottom bunker	Few	9.7	0
Do	Top doorway	Many	3.6	0.9

Effect of Skinning and Maturity

Car E contained experimental lots of tubers of two different maturities that were slightly skinned and others that were severely skinned; one lot had a growing period of 100 days prior to digging, while the other had a growing period of about 115 days. These potatoes were dug carefully by hand but it was found that despite extra care in digging and handling, the tubers could not be delivered to the packing shed without being skinned somewhat. Since it was impossible to obtain nonskinned tubers a separation of those slightly and those severely skinned was made. The terminal inspection of these lots is given in table 4.

Table 4. Effect of skinning and maturity on condition of Shafter potatoes after shipment to New York

Maturity age from planting	Degree skinned	Condition upon arrival in New York		
		Discolored		Decayed
		Slight %	Severe %	%
100 days	Slight	45.6	4.5	0
100 days	Severe	64.1	18.3	0
115 days	Slight	32.6	2.7	0
115 days	Severe	48.5	12.2	0.4

These potatoes were held for six days after arrival in New York during which time no rot occurred but the percentage of severe darkening increased. Severe darkening increased about 20 percent in the slightly skinned lots and between 50 percent and 60 percent in the severely skinned lots.

Shrinkage in Transit

Car E also contained experimental lots of potatoes that had been measured for circumference and weighed. The loss in weight and shrinkage in size during nine days en route under Rule 240, iced at Needles, is shown in table 5.

Table 5. Shrinkage of Shafter potatoes in transit

Lot	Age from planting	Description	Loss during 9 days under Rule 240 [1] Weight	Circumference
			%	
1	100 days	Slightly skinned	1.9	
2	100 days	Severely skinned	2.0	
2a	115 days	U.S. #1	1.1	[2]
3	115 days	Slightly skinned	1.6	
4	115 days	Severely skinned	3.1	

[1] Iced at Needles.

[2] Circumference shrunk .5 c.m. or about 4 percent during six days' holding at room temperature after arrival at New York. These potatoes showed some skinning, but less than in any of the experimental lots.

Summary

From May 31 to June 10, 1938, six experimental shipments of early potatoes were made from Shafter, Calif., to Chicago and New York.

Most of the shipments were forwarded under Rule 240; i.e., initially iced after loading and not reiced in transit. The temperature of the load at the doorway under Rule 240 reached 45° to 50° on the third or fourth day and held at about this temperature for the rest of the trip. The bottom bunker positions were 10° to 15° colder than the top doorway for the first 48 hours after icing and 4° to 10° colder during the remainder of the trip. Under ventilation, the average temperature of the load reached 67° to 70° on the fourth day and remained within this range during the remainder of the trip. Under Rule 240, the load was cooled to the carrying temperature in the shortest time when the cars were iced soon after loading. When the cars were shipped on a cool night the temperature of the load dropped 5° to 10° before the cars were iced. On normally warm

nights, however, little or no cooling occurred during the time the vents were open en route to the icing station. A temperature of 47° to 50° was maintained from Shafter to Chicago by precooling the potatoes and shipping under Rule 240, iced at Shafter. A temperature of 60° to 65° was maintained by shipping precooled potatoes under ventilation.

Of the three cars shipped on three consecutive hot days the first was precooled and iced; the second precooled, not iced; and the third not precooled, ventilated. The precooled and iced car arrived in perfect condition while the ventilated car arrived with a considerable percentage of decayed and discolored tubers. The precooled car shipped without ice had an intermediate carrying temperature, compared to the other two cars, and arrived in better condition than the warm car but not as good as the cold car.

The three cars shipped on two consecutive cool days were iced at either Bakersfield or Needles. The cars iced at Bakersfield cooled faster than the one iced at Needles but all three arrived in good condition. No nonprecooled shipment under Rule 240 was made during hot weather and therefore no data were obtained on the carrying quality of potatoes under these conditions. The marked improvement in carrying quality obtained by precooling indicates that icing as soon as possible would be desirable in hot weather.

The fact that three cars shipped under Rule 240 during cool weather arrived practically out of ice indicates that during warm weather an additional icing in transit might be needed to maintain the load in best condition.

In tests to determine the effect of various handling methods on carrying quality, browning of skinned areas and scald were increased by exposing the tubers to sunlight after digging. Browning was very much increased by exposing the tubers to the wind under either shaded or exposed conditions. Browning was most severe when the potatoes were thoroughly dried after washing and were carried in the warmest part of the car (top doorway). This position is also the driest part of the car. The number of tubers with sticky surface and decay was least when they were thoroughly dried and loaded at the top doorway. The control of decay at the doorway was probably due to the dry atmosphere prevailing in this warm part of the car. Tubers dug about 100 and 115 days after planting showed no material difference as to decay in transit. The more mature tubers discolored much less than those 100 days old. At both maturities severely skinned tubers discolored more than slightly skinned ones.

U. S. No. 1 stock lost about 1 percent in weight during 9 days in transit under Rule 240. Experimental lots of slightly skinned stock lost 1.7 percent and severely skinned stock lost about 2.5 percent. No shrinkage in circumference was observed upon arrival at eastern market but in one lot there was slight shrinkage in size six days later.

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R. L. Perry, Division Agricultural Engineering, University of California, Davis, Calif.